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Aging patterns in different environments of isoclonal individual E.coli

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Introduction

Senescence patterns are influenced by genetics, the environment and often neglected stochastic events.

Here, we work with isogenic populations and control the environment by using a high throughput microfluidic device, that traps thousands of individual E. coli cells and tracks them over their lifespan.

We evaluate how changes in temperature and nutrient levels change senescence patterns.

Method

A population of *E.coli* MG1655 is grown from a single colony to its early exponential growth phase (OD 0.4-0.5). The cells are concentrated and loaded on a microfluidic chip by centrifugation.

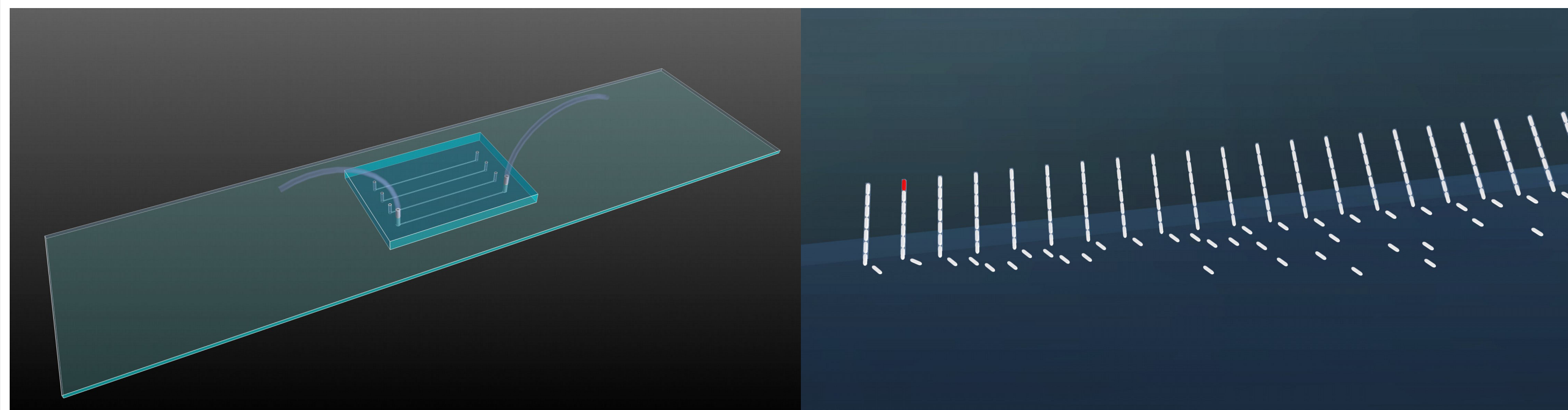


Figure 1a and 1b: (a) general view of the microfluidic chip, (b) detailed view of side channel where the bacteria are trapped

The chip⁽¹⁾ is connected to a constant flow of nutrient media and placed under an inverted microscope. In such chips, we follow cells throughout their lifespan.

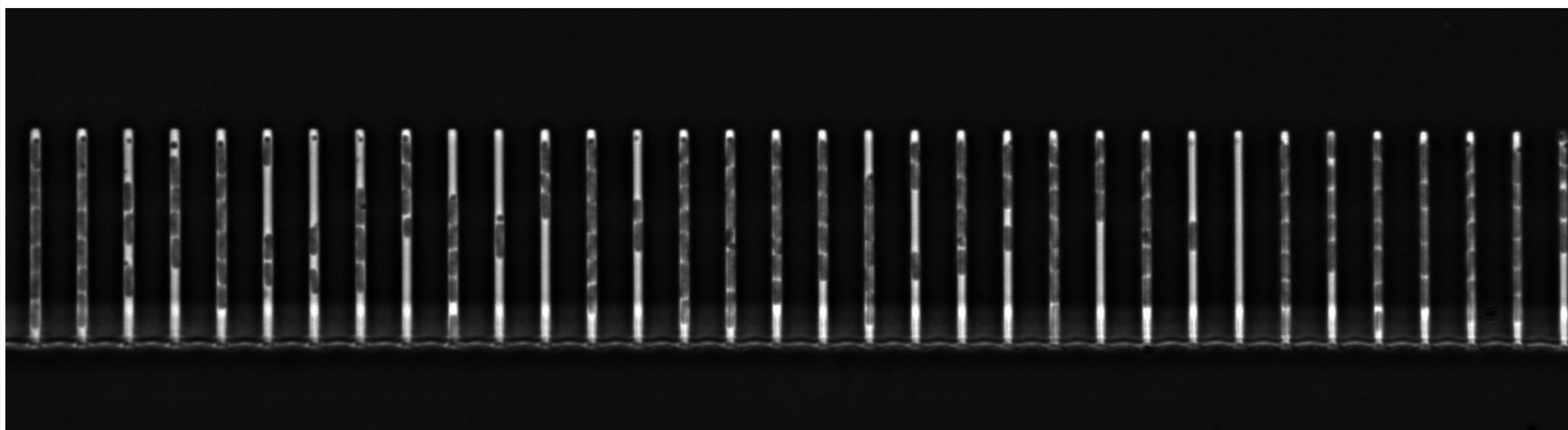


Figure 2: field of view of bacteria in the side channels

The time-lapse images are then treated by images analysis. The output data are then analyzed to measure the rates of cell elongation, cell division and cell survival.

Example of image analysis output

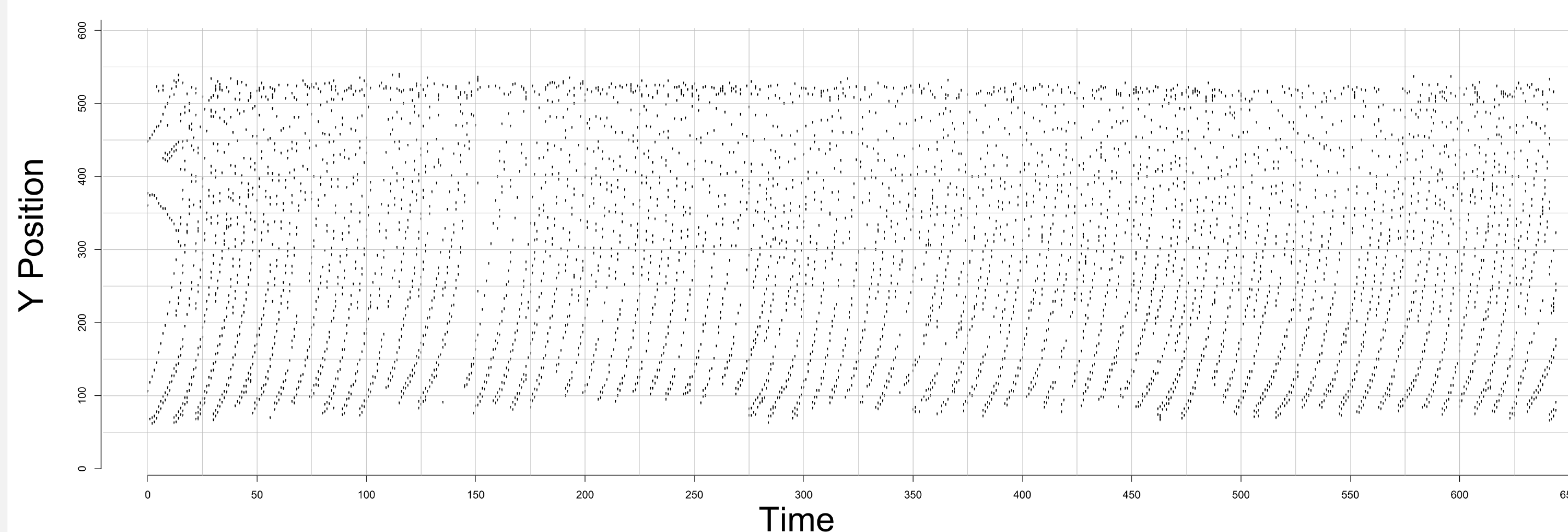
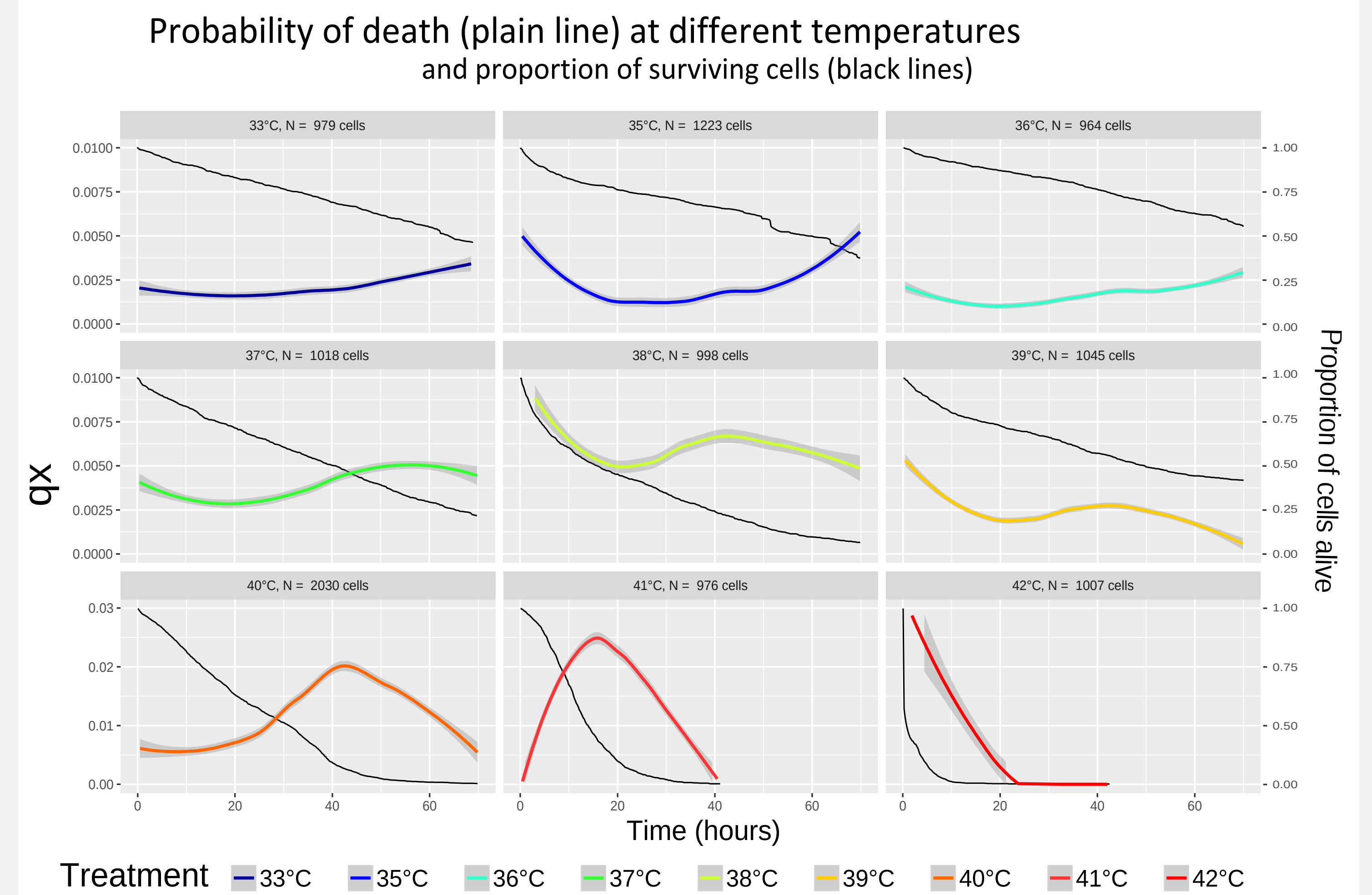


Figure 3: pre-processed image used for the analysis

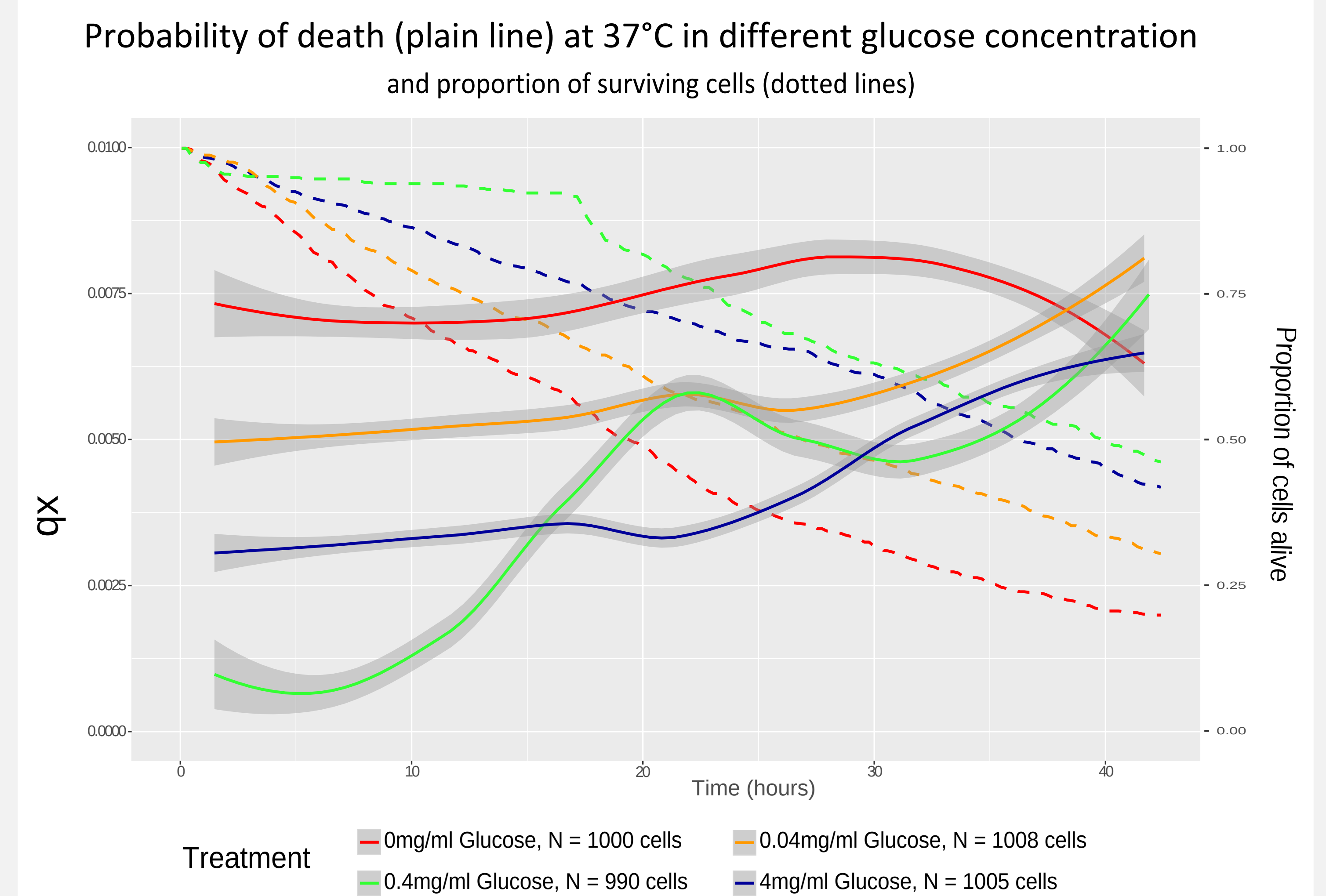
The cells are grown in range of temperature (33°C to 42°C), or at 37°C with 0, 0.04, 0.4, 4mg/ml glucose

Ref: (1) Wang P et al. "Robust growth of Escherichia coli", Curr Biol. (2010), 20(12):1099-103.

Aging in different temperature and carbon source environments



At lower temperature, the data are right censored, as more than 50% of the cells are still alive after 70hours. The mortality pattern is scaled with the temperature.



The nutriment level shifts the mortality pattern, and calorie restriction shows the lowest mortality (green curve).

Conclusion and future work

With changing temperature, we observed a scaling of mortality patterns and shifting of mortality with nutrient level. Low calorie diet appear to lower mortality, higher levels increasing mortality. This might indicate that the intrinsic stochastic processes are scaled to the environment.

We are only at the beginning in understanding the evolution of stochastic variation across genotypes and environments. In future work, we aim at investigating if stochastic variability is adaptive and how phenotypic variability evolves. The experimental setup opens the door to move from descriptive to a predictive approach of biodemographic parameters.